need a dedicated subroutine. The circuit in **Figure 1** uses an 8-bit, 18-pin PIC microcontroller and a decade counter to drive one or two 5×7 LED units to provide a display module of two or four digits. The circuit uses a small pushbutton switch to increment the counter. By default, the circuit works in high-brightness mode. If you press the pushbutton during power-on, the circuit works in low-power mode.

You can download two assembly source codes that take up fewer than 256 words at www.edn.com/120216dib. Each uses a top-down scan-line multiplexing technique in a high-brightness mode, in which you can turn all LEDs in a scan line on or off, and a low-power mode, in which you can turn only one LED at a time in a scan line on or off. EDN

Use an integrator instead of coupling capacitors

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An ultrasonic sensor circuit requiring self-adjustment to the level of an ac-input signal also must accommodate the signal's unknown and variable dc-bias voltage. The circuit cannot use an ac coupling capacitor, and the resulting output must be level-shifted to a known dc offset. The design uses a dc-offset compensator (**Figure 1**).

For proper circuit operation, use a single-supply, high-input-impedance, rail-to-rail-input/output dual operational amplifier similar to the AD822 (**Reference 1**). You can adjust the reference voltage, V_R, using potentiometer R_1 to set the output offset level, which is equal to the reference voltage and usually half the supply voltage, V_{CC}, for full dynamic range. IC_{1B} amplifies and inverts the high-frequency ac-input signal with a gain of R_4/R_3.

Subtracting integrator IC_{1A} provides compensation of any unsuitable offset voltage within the negative-feedback loop. The ac-signal component attenuates based on R_2C_1 values, leaving only the averaged dc-offset component to hold the IC_{1B} output's average voltage equal to the reference voltage. **Figure 2** shows the compensation action for a bias step of 4V, which completes in approximately 100 msec.

This device has two additional useful features. It is a first-order highpass filter in which the frequency-response fall-off is 6 dB/octave, with a −3-dB cutoff frequency of $1/(2\pi R_2C_1)\times R_4/R_3$. The cutoff frequency is 47 Hz for the circuit values in **Figure 1**. This circuit also works as a differentiator to step changes in the dc input with constant-output offset voltage. EDN

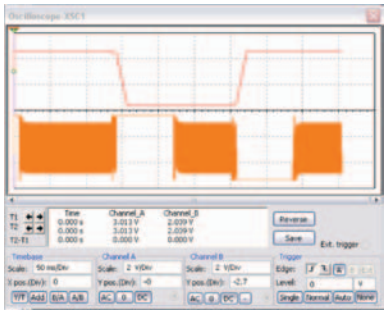

Figure 2 The compensation action for a bias step of 4V completes in approximately 100 msec.

REFERENCE

1 "AD822 Single-Supply, Rail-to-Rail Low Power FET-Input Op Amp," Analog Devices Inc, 2003, http://bit.ly/yckb04.

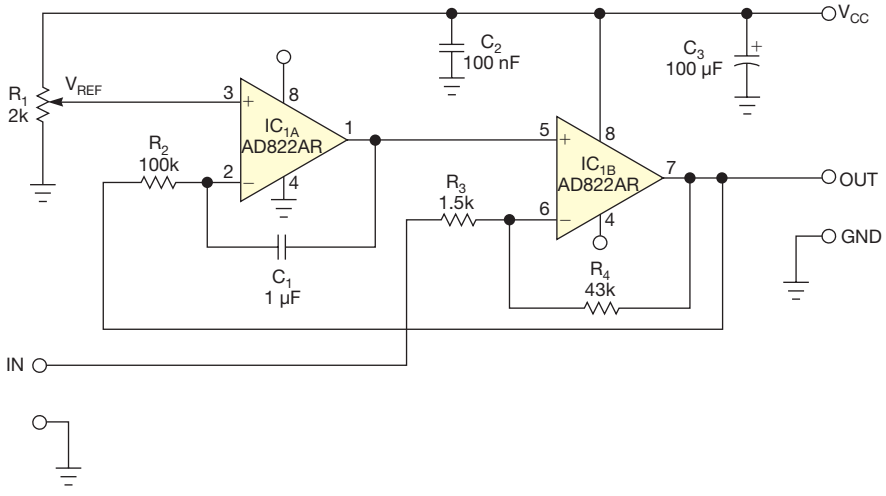

Figure 1 An ultrasonic sensor circuit uses a dc-offset compensator.